

or, since τ (the period) $= 2\pi a/mV$, the loss of energy in one complete vibration is given by

$$-\frac{dE}{dt} \cdot \tau = \frac{8\pi^4 a^4 \epsilon^3 e^{2a_2 r}}{m^2} \{J_{2m-1} - J_{2m+1}\}. \quad (49)$$

With this we have to compare the total energy to be found within the sphere. The occurrence of the factor $e^{2a_2 r}$ is a complication from which we may emancipate ourselves by choosing r great in comparison with a , but still small enough to justify the omission of $e^{2a_1 r}$, conditions which are reconcilable when ϵ is sufficiently small. The mean value of $P^2 + Q^2 + R^2$ at a small distance ρ from the circular axis is $2m^2/a^2\rho^2$. This is to be multiplied by $2\pi a \cdot 2\pi\rho d\rho$, and integrated from ϵ to a value of ρ comparable with a , which need not be further specified. Thus

$$E = \frac{8m^2\pi^2}{a} \int \frac{d\rho}{\rho} = -\frac{8m^2\pi^2}{a} \log \epsilon; \quad (50)$$

$$\text{and} \quad -\frac{dE}{E} \cdot \tau = \frac{\pi^2 \{J_{2m-1}(2m) - J_{2m+1}(2m)\}}{-\log \epsilon}, \quad (51)$$

in agreement with (23).

On the Apparent Change in Weight during Chemical Reaction.

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(Communicated by Prof. J. H. Poynting, F.R.S. Received May 29,—Read June 27, 1912.)

(Abstract.)

In this communication are considered some of the causes which give rise to apparent changes in the total mass of chemically reacting substances.

A short review of the work of and the conclusions drawn by the late Prof. Landolt is first given, and then we deal with the conditions under which one of Landolt's final experiments was repeated by us. Next our balance and reaction vessels are briefly described, together with the preliminary treatment to which the latter were subjected prior to their being weighed. Following this, our first plan for weighing is outlined and then illustrated with the aid of data given in the form of tables and otherwise; then, by means of an actual example, the method adopted for calculating final results from our two series of preliminary experiments is explained.

After a brief discussion of our first results, we indicate four chief sources of error, and then, for given cases, consider their possible quantitative effects upon the apparent weight of a charged glass vessel. So far as we are aware, Landolt omitted the consideration of minor errors arising from the possible existence of (1) air streams within his balance case, and (2) differences in the superficial areas of his reaction vessels and the consequent possibility of a variation in the relative weights of any water skins upon the same. Further, from his memoir, it does not appear that any very close attention was paid to effects producible by very slight and varying differences in the temperature of the contents of any pair of his reaction vessels. For our present purpose these several points are of extreme importance, and accordingly devices were introduced for eliminating and neutralising the errors indicated; they are here fully described and discussed.

Having directed attention to the probable existence and nature of certain minute but effective errors in Landolt's experimental work, there are then given some results obtained under the new and improved conditions which are, it is believed, necessary for securing trustworthy values during the most refined weighings.

One of the concluding sections of the paper is devoted to a preliminary consideration of a new and hitherto unsuspected secondary chemical reaction occurring within our reaction vessels. It is shown that this reaction may be somewhat accelerated by heat and greatly so by light from a "tantalum" lamp; and it is further shown that as a result of the secondary reaction, which is, under ordinary circumstances, long continued, it was impossible with silver nitrate and ferrous sulphate solutions to reach any definite conclusion in our enquiry.

We then prove that by making use of a quickly terminating and practically perfectly complete chemical reaction, such as that which follows the mixing of solutions of barium chloride and sodium sulphate, decisive results may be secured.

Next we show that by availing ourselves of the now numerous devices and precautions which we have on more than one occasion introduced and advocated, the degree of accuracy in weighing to which Landolt attained and which he affirmed as the limit attainable under his own conditions of weighing, has been increased just fivefold. Landolt's estimated limit was ± 0.03 mgrm.; we find ours to be in the case of charged Jena glass vessels equal to ± 0.006 mgrm.

Of the precautions and devices introduced and advocated for use in connection with refined weighings, special attention may be directed to the following:—

(1) The necessity for duly fatiguing the balance beam prior to effecting any final weighing.

(2) The ensuring, by means of an inner and auxiliary case, of a practically perfect uniform temperature throughout the beam of the balance.

(3) The extinction of air streams in the immediate vicinity of the balance pans.

(4) The plan for continuously supplying very dry and carbon-dioxide-free air to the interior of the balance case, with the consequent removal of water skins from any objects that are to be weighed.

(5) The employment of a tilt indicator whereby the horizontality of the balance shelf can, at any time, be almost instantly tested.

Finally, we may state that Landolt found the mean apparent change in mass during chemical reaction to be not greater than 1 in 1×10^7 . With the aid of our additional devices and precautions we show that in one very fully investigated case in which barium chloride and sodium sulphate were the reacting bodies, the apparent change in mass was not greater than 1 in 1×10^8 .

Morphological Studies of Benzene Derivatives.—III. Paradibromobenzenesulphonates (Isomorphous) of the "Rare Earth" Elements—a means of determining the Directions of Valency in Tervalent Elements.

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In a communication on the "Classification of the Elements" brought under the notice of the Society by one of us in 1902,* a method of ordering the elements was advocated which was different, in essential respects, from that we owe to Mendeléeff, more especially in that it involved the systematic application of a principle dominant in organic chemistry—the principle of homology—in a manner and to an extent not generally recognised as necessary at that time.

The subject has been further discussed in a recent lecture to the Royal Philosophical Society of Glasgow,† various issues being considered which have been brought into prominence in the meantime—*e.g.* the atomic

* 'Roy. Soc. Proc.,' 1902, vol. 70, p. 86.

† 'Glasgow Roy. Phil. Soc. Proc.,' 1912; 'Science Progress,' 1912, No. 24.